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ABSTRACT

A Science Skills Center was designed and operated as part of an NDEA Summer Institute for Teachers in Grades 6-9, in which 40 teachers participated. These teachers were provided with the opportunity to participate in demonstration centers working with some 90 children, whose reading scores ranged from 3.0 to 8.5, and who ranged in age from 11 to 14. Thirty of the children worked in the Science Skills Center. These children also worked in Reading Skill Centers, which were designed as learning laboratories where children work individually, or in small groups, interacting with self-directing materials which were matched to diagnosed needs. The Science Skills Centers provided learning experiences which integrated reading with highly motivating science experiences. The science experiments provided the children with a concrete meaning for words, and provided the opportunity to learn science concepts and processes. The children responded enthusiastically to the various tasks in which they were involved. Reading gains of approximately one-half of a grade were obtained. [Not available in hardcopy due to marginal legibility of original document.] (BR)

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A SCIENCE SKILLS CENTER APPROACH TO DEVELOP FUNCTIONAL LITERACY AMONG SOCIALLY DISADVANTAGED YOUTH

AN NDEA SPONSORED LABORATORY DEMONSTRATION PROJECT

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A SCIENCE SKILLS CENTER APPROACH TO DEVELOP FUNCTIONAL LITERACY AMONG SOCIALLY DISADVANTAGED YOUTH

Much evidence exists that large portions of pupils in junior high schools servicing depressed urban areas are from two to five years or more retarded in reading ability.[1] Such pupils are found to be academically retarded in all subject areas and well along in the progression which includes academic failure, negative self-concept, alienation and withdrawal from school. Nevertheless, it has been demonstrated that, even at this advanced stage of retardation and language deficiency, substantial remediation can be achieved through appropriate instructional approaches.

For the past four years successful experiments have been conducted in the development of meaningful learning experiences with children who have been classified as "slow learners," emotionally disturbed, non academic achievers, functionally illiterate, unmotivated, in short-disadvantaged because they come from the ghettos of a large urban community and have exhibited very little academic achievement in the classroom.[2] These pupils were involved in programs which structure an environment conducive to learning in underachievers burdened by serious psycho-social pressures, with histories of school failures and delinquency. Such an environment sets learning as its main priority and learning is defined operationally as an active rather than a passive function.

These programs have been guided by such well known "laws of learning" as:

Active participation by a learner is preferable to passive reception. High intensity learning, a primary feature of these programs, was assured through the use of individualized instruction. Through the use of self-directed materials, which could be used either individually or in learning teams, and where the teacher was free to serve as a resource, the program was tutorial while preserving the advantages of a group experience.

Meaningful tasks are learned more efficiently than tasks not understood by the learner. The tasks used in the program provided the pupil with information about the nature of a good performance, knowledge of his own mistakes, and knowledge of successful results-significant aids in the learning process.

1. "The Administrative Services to Children and Youth in New York City," Institute of Public Administration Research Center, Columbia University School of Social Work, 1964.
2. David Vitrogan, "Scientific Literacy and the Socially Disadvantaged Youth" A Laboratory Demonstration Project," School Science and Mathematics Volume LXIX, Number 7, whole 612, October 1969, p. 618

The ability for a pupil to learn from an individual teacher may be hampered or enhanced by the pupils personal history such as his reaction to authority.

A motivated learner acquires what he learns more readily than one who is not motivated. Learning under instrinsic motivation is preferable to learning under extrinsic motivation. The programs were built on achievement success rewards and tended to reinforce the researches which have shown that success feeds on itself and drives the pupil to further achievement.

Tolerance for failure is best taught through providing a backlog of success that compensates for experienced failure. In these programs learning goals are defined operationally in very specific subskills as pupils move step by step through a complex pattern with high incidence of success. Success is thus built in, so that it can compensate for an occasional failure.

The programs in which these pupils were involved may be viewed as an approach to compensatory education which provides an instructional mode most suitable for their involvement of these pupils in the learning process. The major objectives of these programs have been to provide these pupils with skills which will enable them to become functionally literate and successful learning experiences which will help them

a) to develop a desire to read
b) accept remediation toward their reading difficulties
c) accept the possibility that school is a place where one can gain certain positive socializing experiences
d) develop an awareness that successful school experiences can help them in attaining marketable skills essential for occupational careers.

The success of these programs can be attributed to at least three factors:

a) the great desire on the part of the "teachers" to reach these pupils
b) the attitude on the part of the teacher to view them as individuals who are capable of learning
c) the creative nature of the experiences in which the pupils were involved, namely, highly challenging science oriented activities.

The desire to reach them was reflected in an attitude which made these pupils aware that the "teacher" sincerely believed that they could succeed thereby resulting in an attitude on their part which inspired confidence and resulted in breaking down the pattern of defeat with which these children had become conditioned to view the typical classroom situation.

Since the science experiences were found to be challenging and highly motivational by these pupils, they were observed to respond quickly not only in terms of the skills and learnings essential to discovering the science concepts involved, but they also participated and derived a great deal of satisfaction from the reading, writing, and verbalizing experiences to which they were exposed. These experiences included reading and writing exercises involving word attack skills, vocabulary development, reading comprehension, descriptive, narrative, exploratory, and creative writing. Although the reading and writing exercises were concerned with the processes and content of the immediate science experiences, they did involve a great deal of contemplation, critical analysis, and the use of abstract ideas and generalizations. In short, the successful and motivating science activities were integrated with the language arts experiences and these pupils responded as well as one would expect from normal academic achievers in this age group.

The activities in which the pupils were involved, the science experiments as well as the language arts experiences with which they were integrated, differed from the traditional classroom experiences in two ways, in their content as well as in their method of presentation. Although the science concepts involved have been included in the elementary school curriculum, for at least five years, the activities relating to them were designed and presented in a way which these pupils found very challenging. Moreover, most of the materials were improvised from readily available commercial equipment.[3] But to make the experiences meaningful and motivationally exciting to these children a great deal of time and effort was spent in assembling, adapting, and detailing the exercises which were desired. This resulted in experiments in which the pupils were involved in high intensity learning situations requiring them to work individually or in small learning groups on self-directing materials that present a series of programmed stimuli to which each individual responds. Learning was thus found to be active and continuous. Moreover, every pupil moves at his own speed since the material is self-directed and self-correcting.

The Science Skills Center Activities

The Science experiences and the language arts activities with which they were integrated are described below in some detail in order to reveal the rationale, the method, and the content of these activities.

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3. See Appendix I

The Science Skills Center was designed and operated as a part of an NDEA Summer Institute for Teachers in Grades 6-9, and involved forty teachers from greater metropolitan New York City. These teachers were provided with the opportunity to participate in demonstration centers working with some 90 pupils, whose reading scores ranged from 3.0 to 8.5 and ranging in age from 11 to 14, from lower Manhattan schools. Thirty of these children worked in the Science Skills Center and comprised ten from the top third, ten from the middle third, and ten from the lowest third of the 90 on the basis of their pretest reading scores on the California Achievement Scale. It was anticipated that there would be peer-to-peer teaching and from such a grouping it was observed that those pupils who read assisted the poorer readers with the interpretation of the instructions needed to carry out the science tasks.

These pupils also attended the Reading Skills Centers where they were engaged in self-directed word study and work study skills, reading comprehension, and literature writing skills. All the skill centers are learning laboratories where the children work individually or in small groups, interacting with self-directing materials which are matched to diagnosed needs. The centers were directed by teachers who diagnosed the needs of the pupils, matched materials to individual needs, and provided information to the pupils when they required it. The pupils checked their own progress, since the materials which were programmed to meet individual needs were also self-correcting. In the Science

Skills Center, self-correction was readily achieved in terms of immediate perceptual checks on the completion of each task. The results of such learning laboratories have been found to be high motivation, high intensity learning, measurable gains in problem solving and reading achievement, and most important, a desire to read in order to achieve success with the more complex tasks.

The Science Skills Center provided for the thirty pupils the opportunity to engage in self-directing and self-correcting learning experiences which integrate reading with a highly motivational science experiment. Basic skills involving the manipulation of materials, following directions which were provided in both illustrated as well as written form, classifying and identifying components needed to carry out each experiment, naming the components in written form, and learning to use materials for a simple logical order in a step-by-step procedure in the solution of a problem were integrated with such process skills in science as observation, classification, measurement, and recording. The more complex tasks required the pupils to learn to use logical procedures in problem solving, invent logical procedures which required them to use a rational and sequential ordering of previously acquired skills. The acquisition of these skills were then applied to situations where they were challenged to identify problems, ask relevant questions, hypothesize, predict, test, and infer from recorded data.

Thus activities of this program were structured, described, and evaluated in terms of communication skills which were integrated with science process skills. It was observed that scientific facts were learned in relation to procedures in scientific inquiry and the associated communication skills essential for their full understanding.

The Procedure Used in the Integration of Language Arts and Science

In structuring a language arts experience based upon a science activity the following outline was used:

I. Introductory paragraph

A motivating statement which introduces the pupil to the activity, exciting his curiosity to explore the physical phenomenon and its relation to the world about him; this introduction also indicates some of the understanding which is needed to carry out the investigation.

II. Vocabulary Development

A self-directing, self correcting kit which includes:
Words and Pictures-Flashcards in Envelopes
Words Using Directions in Carrying Out the Experiment-Flashcards in Envelopes
Meanings of the Words in Context of the Experiment
Multi-meanings of Words Beyond the Experiment to be Used later for Verbalization and Creative Writing Experiences

III. Reading the Directions for Carrying Out the Experiment

Identifying the parts to be used in the experiment
Writing a Parts List
Reading Directions for Assembly of the Equipment for Carrying Out the Experiment

It is suggested that these three tasks are mastered by the pupil prior and he is satisfied through his own evaluation of these tasks prior to continuing the activity; but he may proceed at his own rate and continue at times prior to such mastery. It was observed that for some children, in the beginning of the activities it was essential for them to succeed in learning the science principle first and greater mastery was shown even by those children who at first preferred to carry out the physical experiment.

IV. Performing the Experiment

Following the directions provided
Recording the necessary observations in order to complete the task

V. Writing a Descriptive Paragraph Based Upon the Experiment Performed
Pupil is directed to write a simple description of what he did, emphasizing the purpose and fuction of each part of the equipment he used and what he observed. He is also asked to make any necessary drawings which may elucidate what he did.

VI. Comprehension Check

The pupil responds to a short paragraph which describes what he should have observed and some of the possible inferences he might make. He answers questions based upon the above written paragraph and checks his answer against a prepared list. Here both comprehension of the reading experience is used, while at the same time he is asked to review the science concept which he has mastered.

VII. Pupils Written Description of the Total Experience

A descriptive paragraph which explores his conception of what he did as a result of the experiment performed and the reading and writing experiences described above. Essentially he now responds in terms of his understanding of the science concepts learned and the reading experiences in which he has been engaged. He can be guided into such a writing experience by means of a series of open-ended questions, or motivated to write a creative paragraph.

VIII. Feedback

Pupil is asked to identify the various parts of the experiment the functions that they serve in solving the problem, the reason for the procedure that was used in solving the problem.

He is also asked to write sentences which require the words within the context of the experiment in multi-meaning context. Self-checking is provided throughout this exercise.

The experiments which were used included a number of experiments in electricity which used materials supplied by Essex International, the assembly of a flashlight, an electromagnet, a bell, a motor, etc. Since each pupil responded to an instructional program working in his own individual booklet and answer sheets, samples of the pupils work are included in the appendix. (Sample Books are available for inspection upon request, and are available at the speaker's desk. Please be sure to return these to the desk.)

Other tasks involved experiment in light transmission, reflection, refraction, and dispersion. In one experiment the children built a kaleidescope, in another they produced a spectrum by use of a plastic replica of a diffraction grating, in a third they used the "How Come Box," previously described. Some experiments were concerned with indirect measurements of large distances, learning how habits are formed, and the processes involved in solving problems.

An example of one of these experiments is outlined below and shows the steps used in developing the language arts experience.

Changing Shapes

Introduction

The imagination of the young child remains with us as we grow up. and how wonderful it is that it does. Daydreaming on a beautiful day can take many forms, and on a lazy sunny summer afternoon, no matter where we may be, as long as we are out of doors, we can look up at the clouds and imagine that the passing clouds take on any fanciful form we may want. Passing clouds can become for us flying fish or elephants, skyscrapers or rockets, indeed any beautiful form that we wish to see. The same imagination will enable us to see many beautiful, fanciful, and changing forms when we look through the kaleidoscope which we will make in this experiment. Just as we know that we are really looking at clouds, although the forms we imagine may be continually changing, so the patterns and designs which we see continually changing when we look through the kaleidoscope, which we will build, must be the workings of our own imagination. These patterns are really our own and we cannot share them with any one else. There

is something beautiful about having something which belongs to each and everyone of us alone and which no one else can have.

Vocabulary Development

Select the vocabulary cards with the same words that have been underlined in the above paragraph. Write them on the card provided. Do you know what they mean? Look at the flashcards which have a picture next to the word. Does this help you understand the meaning of these words?

Directions for Making a Kaleidoscope

Look at the material which has been given you and place a check next to each part.

two metal mirrors _____ one V - shaped piece of cardboard _____

gummed tape _____, a pencil _____, a piece of colored paper _____

Put the two mirrors fact-to-face to make a narrow V - Shape. Hinge together the long edges with the gummed tape. Put the hinged mirrors inside of the V-shaped card board. Hold the card board with one hand, near the corner of the V, and be prepared to look through the other end.

Vocabulary Development

Underline the words listed below when you find them in the above paragraph:

metal	shaped	together
mirror	hinged	long
gummed	inside	edges
tape	board	narrow

Find the flash cards with these words. Do you know the meaning of all of these words. Do you know what to do to find the meaning of all these words? If you do go ahead and check them out. Look at the answer card which has been given you to check your understanding of those words whose meaning escaped you.

Did you enjoy looking through your kaleidoscope? Yes _____ No ____

What did you like best?

What did you imagine you would see when you looked at your partner through the kaleidoscope?

Look through the store bought kaleidoscope and try to see where the object that you are looking at is. Can you identify the object? Describe the image as you see it? Say something about its color and its symmetry, the number of images you saw, and how you feel when you see more than one image.

What causes the images that you see inside of the kaleidoscope. Before you answer this question turn the kaleidoscope around so that you may look into the opposite side. Do you see the two mirrors? Yes _____ No _____. How large is the angle between them? 10 degrees _____ 20 degrees _____ 30 _____. Set your kaleidoscope at the same angle and measure it with the protractor provided. Now look at the same object that you looked at with the store kaleidoscope. Is there any difference in the image you see? _____ If there is change the angle until the image is the same. Keep trying until you are satisfied. Now explain the difference that still exists.

Since there is no real object inside the store kaleidoscope but there is one in the kaleidoscope you made, can you explain why you still see the image in the store one? Try to imagine a world where nothing is real but everything is only an image of the real thing. How would you feel about such a world?

Tentative Conclusions:

The children in our skill center at Yeshiva showed remarkable achievement in terms of the anthusiasm with which they responded to the various tasks in which they were involved giving inspiration and encouragement to the participating teachers of the Institute of the effectiveness of this approach. Further factors of achievement can be gleaned from the books which they kept and the reading and writing activities which they exhibited.

The children were exposed to six weeks of skills center learning and within this short period showed gains which have been previously obtained through such experiences. They were pretested and posted in reading using the California Reading Tests. It was found that the top third showed a gain of 0.6 of a grade; the middle third 0.5 of a grade, and the bottom third 0.4 of a grade. They demonstrated greater growth in comprehension then in vocabulary. These are measurable results and in general have been obtained in previous experiments with similar programs. More striking is the fact that the standard deviation for the post test is larger than for the pretest, and incidently the range is also greater for the post test. Since it is our experience that a good program yields greater individual differences, while the traditional program tends to "lock-step", i.e. all children move ahead in step, it is seen that this program did yield greater individual differences.

Implications of this Project

The Science Skills Center - is a practical approach to educating under-achieving disadvantaged youth. It is particularly effective for use in schools which are plagued by rigid class schedules, restricted physical plants, large pupil teacher ratios, and low staff morale. The program structures an environment conducive to learning in under achievers burdened by serious osycho-social pressures, with hostories of school failures and delinquency. The format which has been described as the

procedure for an integrated approach to language arts and science leads to a reduction of teacher directed activities, in which teachers lecture, explain or address an entire class, to self directing, differentiated learning by individuals or small pupil learning teams. When pupils are self-directed, the teachers role changes drastically. The teachers role in implementing a Science Skills Center is one of arranging the conditions conducive to learning by structuring a classroom in which learning can take place. This involves such activities as teaching the pupil how to teach himself, insure success by carefully matching materials to needs, diagnosing, guiding, interpreting, and evaluating growth as a service to the pupil and not as a judgment. The teacher, in such a setting, is also involved in supplying on-the-spot first aid when materials do not work or when they are unavailable, develop new materials to solve problems and personally interact with small groups and individually.

A teacher who expects to duplicate the results achieved in this demonstration project with any group of children, advantaged or disadvantaged will sincerely tax her imagination in preparing, and adapting materials for her specific pupils to develop the science concepts involved and especially the exercises for the reading and writing skills which she wishes to achieve with her pupils. She may feel free to use the suggested outline or any portion which she may find helpful. Examples

of the procedure which have been presented here and in the appendix as well as the source of materials and activities suggested in the appendix may also be helpful. The task is a hard one and very time consuming. But, isn't this what teaching is all about? I am firmly convinced that teachers who really want learning experiences in their classrooms are continually using their creative talents and imagination to produce an environment in which children are challenged to try problems which have real meaning for them. Certainly, the teachers with whom I have worked at Yeshiva University in the past four years, both in in-service and pre-service programs have demonstrated this many times. Also most of the elementary school teachers with whom I have discussed these ideas during the past decade have described their experiences in the classroom and corroborated this observation. Hard work which is generally time consuming comprises the ingredient of teacher preparation for successful learning experiences when behavioral goals are the objectives of teaching. But the pay-off, a child develops a pattern for learning how to solve problems and an attitude that school is a place for learning, provides an emotional satisfaction that no other occupation can equal.

Appendix I

NDEA SUMMER INSTITUTE

TASK GROUP- SCIENCE SKILLS CENTER
Dr. Vitrogan

MOST MATERIALS FOR THE SCIENCE EXPERIENCES THAT YOU HAVE OBSERVED IN THIS CENTER ARE READILY AVAILABLE IN YOUR SCHOOL. IT IS SUGGESTED THAT YOU CONSULT THE SCIENCE TEACHER AT YOUR SCHOOL. TO MEET THE INDIVIDUAL NEEDS OF ALL OF YOUR PUPILS IT IS SUGGESTED THAT YOU INCORPORATE INTO YOUR READING SKILLS CENTER SOME ROOM AND MATERIALS FOR SOME OF THE SCIENCE EXPERIENCES FOR THOSE CHILDREN THAT YOU FEEL WILL BENEFIT MOST FROM SUCH ACTIVITIES. FOR THAT PURPOSE A LIST OF PLACES WHERE SUCH MATERIALS CAN BE OBTAINED IS PROVIDED BELOW.

Supplier	Materials	Experiment	Approx. Cost
1. Book-Lab. Inc. 1449 - 37th St. Brooklyn, N.Y. 11218	Metal Mirrors vial caps and droppers magnifying glasses Science Action Sheets for each of the above materials suggesting open-end investigation which can be readily developed into the outline suggested for the language art lesson	Kaleidoscope Air Pressure Action of Water Magnification 50 sheets	6 for $3.00 6 for $3.00 6 for $3.00 $4.00
2. Edmund Scientific Company Barrington, N.J. 08007	Replica Diffraction Grating Complete Spectroscopic Kit	Rainbow Exp. Spectrum	6 for $.50 $2.00

This company generally has great educational bargains in one package; for example, optical bargain No. 50,204 at $3.00 contains the following materials: a prism (can be used to make a rainbow), fun with optica (32 page information and instruction book), Beginners lens kit (instruction booklet and 10 lenses to make small optical items), a star and satellite path finder (with instructions), a diffraction grating (to see the rainbow-spectrum), a rectangular magnifier, various light filters, and double convex lenses (5 lenses which are easy to combine to make useful high power magnifiers. Consult their current catalogue for other such bargains!

3. Essex International 308 Springfield Ave. Berkeley Heights, N.J. 07922	Flashlight Kit Electromagnet" Bell Kit	Flashlight experiment Electricity & "	 Magne- " tism Sound	each item costs $1.00

This company puts put a special kit for the teacher which includes all of the above items, as well as a kit to study light-optica, a kit for a balance (this can be used in the experiment in finding the number of peas in a jar without counting, as well as weighing and measuring), a kit to study water pressure. including a small water pump, etc. The whole assembly costs approximately $9.00; write for their current catalogue.

4. Webster Division McGraw-Hill Book Co. Manchester Road Manchester, Mo. 63011	Music Cards Attribute Games Tangrams	Studies in Symmetry Problem Solving "	"	$12 includes teachers guide $10.40 incl. teacher's guide $5.00 " "

One set of each of the above items and two sets of the tangrams are sufficient for a class of 30.

5. Silver Burdett Co. Box 362 Morristown, N.J. 07960	Four Kits with instructions for assembly and use (easily stored) in Electricity and Magnetism, Wave Motion, Mechanics, and Measurement - one set adequate cost is $25 but materials is very durable.

<u>Appendix II</u>
<u>A Second Example of the Procedure Used</u>:
HOW CAN WE MEASURE VERY LARGE DISTANCES?
<u>Introductory Paragraph</u>

How can we <u>measure</u> the distance to the moon? How can we measure the <u>distance</u> to a <u>neighboring planet</u>, such as Venus or Mars? Can we measure such distances without <u>actually</u> going there? Have you ever thought of the way the scientist measures the distance to the sun?
He tells us that the sun is ninety-three <u>million</u> miles away but we know that he never measured this distance with a tape measure. The scientist has told us when he wants to measure such large distances he must learn how to do this <u>indirectly</u>. In this <u>experiment</u> we shall find out how he makes such an indirect measuremnt by making one ourselves and then <u>checking</u> it by a <u>direct</u> measurement.

Make a list of all the words which have been underlined and then answer the questions below:

Vocabulary (the underlined words)

1.	6.
2.	7.
3.	8.
4.	9.
5.	10.

Scientists sometimes must make _____ measurements.
The distance to a neighboring planet is _____.
The sun is ninety-three _____ miles away from the earth.
It is always possible to make _____ measurements to distant places.
When we learn to make indirect measurements we need not go to _____ places.

Make sure that you have all the equipment needed for this experiment by checking off the following equipment:

a wood ruler a measuring sight a pencil a piece of paper

Look around the room and locate the object which will be measured. If you cannot find it ask the teacher to show you where it is. You are going to measure the distance from you to the object by an indirect method. You will work with your partner, taking turns in looking through the measuring sight which you will share, and computing the distance to the object.

Study the wooden ruler and identify the centimeter markings on it. Place the ruler so that the centimeter scale reads away from you. Put the metal distance measuring sight and slide it on the ruler so that the extended metal piece is facing you. You are now going to measure the distance to the colored stick indirectly.

First, ask yourself the following question. If the length of the colored stick is one foot, how would I measure the distance to it using only the materials which have been provided without moving from my seat? Invent a way to do it and tell your teacher what you want to do. Then, you may go on with the way which is suggested in this experiment.